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Abstract: This article describes a new effort to engage in analytic outreach between academic scholars and intelligence analysts on the issue of emerging biotechnology threats to U.S. national security. The context of this outreach was a September 2012 meeting in London to explore possibilities for enhanced analytic outreach in relation to emerging biotechnology threats, supported by the UK Genomics Policy and Research Forum. This meeting consisted of a mix of current and former intelligence practitioners and policy officials, and social science and scientific experts, from both countries. As will be described below, this unique pairing of experts and subjects revealed new insights into how to improve intelligence assessments on biotechnology and bioweapons threats. It also revealed continuing challenges in reforming assessments within existing intelligence work routines.

In July 2008, the Office of the Director of National Intelligence issued 'Intelligence Community Directive Number 205 (ICD 205): Analytic Outreach,' which calls for intelligence analysts to 'leverage outside expertise as part of their work.'[1] These experts are identified as being drawn from 'academia; think tanks; industry; nongovernmental organizations; the scientific world (e.g., U.S. government laboratories, national academies, national research councils, and Federally Funded Research and Development Centers); state, local, and tribal governments; other non-Intelligence Community U.S. government agencies; and elsewhere.'[2]

With this mandate, analysts are expected to know the leading experts in their portfolios and to seek opportunities to engage openly with them to 'explore ideas and alternative perspectives, gain new insights, generate new knowledge, or obtain new information.'[3] The directive recognizes the importance of moving analysts out of their classified domains to tap into valuable outside knowledge and relevant expertise and to challenge assumptions, cultural biases, and conventional wisdom that can occur in intelligence.[4] Currently, however, the directive remains underutilized because, as one intelligence analyst explains, it is 'pretty much an unfunded mandate.'[5] Although the directive demonstrates high-level support for increased intelligence outreach, it leaves the implementation up to each individual agency and office unit, which 'few do given limited resources and some bureaucratic obstacles (e.g., security clearances, identifying and justifying suitable academics or other experts).'[6]

In spite of these challenges, we have been interested in exploring the benefit that analytic outreach could have on an issue of current intelligence concern: emerging biotechnology threats to U.S. national security. Since the end of the Cold War and the rise of asymmetric security threats, the U.S. intelligence and policy communities have been increasingly concerned about new types of bioweapons attacks that might arise from a spectrum of state and non-state actors. In talking about these concerns at a 1995 U.S. Senate hearing, CIA official Gordon Oehler lamented that 'the increasingly troubled post-Cold War world has, in a curious way, made us yearn for the dark days of the 1960s and 1970s when we knew the kind of target we were dealing with and the problems we were facing.'[7] With the events of 11 September 2001, new scientific developments, and the globalization and diffusion of biotechnology, the number of possible threats has continued to grow.[8] More recently, further concerns have arisen that advances in the life sciences and biotechnology have made bioweapons capabilities accessible to an increasing number of actors, including possible garage bio-hackers, 'mad scientists', and bio-criminals.[9]

In this context, fundamental analytic questions have arisen for intelligence about how to assess bioweapons threats in the coming years:

- How exactly do advances in the life sciences and biotechnology affect the nature of the bioweapons threat in the coming years and decades?
- What are the specific knowledge, skills, conditions, resources, and time scales that enable the development of new biotechnologies and biological weapons?
- Moving from the global to the local, how can one better assess the ways in which a diverse set of actors may develop and use biotechnologies for harm?

The ability of intelligence to tackle these questions and inform policy depends a great deal on how analysts understand and assess the factors and context that enable biotechnology and bioweapons activities to develop and proliferate.

To date, much is still not known about the fundamental drivers of emerging biotechnology and bioweapons threats, how they apply to specific actors and cases, and how these drivers are changing over time. Additional analytic challenges stem from the complexity of biological systems and the difficulty in predicting how innovations and discoveries in the life sciences and related technologies can be controlled and harnessed for misuse---and how, and to what extent, this is a different problem than that posed by older bioweapons threats. Until these fundamental issues are examined in depth, intelligence analysts will face blind spots in their bioweapons assessments, which may lead to future intelligence failures and poor national and international security policymaking.

ANALYTIC OUTREACH AND THE SOCIAL SCIENCES

Previous writing on analytic outreach that has focused on the life sciences has discussed the 'nearly nonexistent' relationship between the life science and intelligence communities, and the need to build 'solid and long lasting' bridges.[10] This was in relation to the publication or control of scientific research findings that might be used for bioterrorism or bioweapons development. In this paper we move away from considering only technical matters to focus on the benefits and challenges of engagement between intelligence and the social sciences. This is an area that has received far less attention and funding than engagements between scientists and intelligence, but poses more complexities for analysis.[11] Thus, we build on these recent calls for 'consistent and productive interaction' between scientists (here, social scientists) and the intelligence community.[12] We agree that the benefits of ongoing dialogue and improved relationships will be multiple, including (especially) access to, and mobility of, expertise across the two groups.

Over the last decade, research and higher education policy in North America, the UK and elsewhere has increasingly prioritized and incentivized 'research impact' and the development of academic connections with external stakeholders, including in the social sciences.[13] In the UK and US, for example, reporting and funding processes by (respectively) the Research Councils and the National Science Foundation have increasingly shifted toward assessing the application and impact of research outside academia.[14] Moreover, in the U.S., there have been recent calls to increase engagement between social scientists and those in intelligence and the military.[15] These shifts at the policy level in diverse countries build on longer-term research and increasing interest in 'knowledge exchange' – the process of exchanging knowledge through dialogue with non-academic stakeholders, notably government departments and agencies.[16] In the context of social science research on bioweapons threats and bioterrorism, the intelligence community is a key non-academic stakeholder. The increasing emphasis on knowledge exchange and research impact in the social sciences over the last five-to-ten years may be seen to mirror the directive to the intelligence community in the same period to increase analytic outreach, discussed in the introduction to this paper. The current policy context for both intelligence analysis and social science thus has the effect of drawing the intelligence and social science communities closer together from both sides.

One effect of the research policy context in the UK has been the funding of dedicated 'knowledge broker' units and posts within universities, to facilitate relationships and dialogue between researchers and non-academic stakeholders.[17] In this context the UK Economic and Social Research Council (ESRC) in 2004 funded the Genomics Policy and Research Forum, a novel initiative dedicated to the development of links between social scientists and scientists working in the contemporary life sciences, and the connection of research in this area to policymakers, business, the media and civil society. The Forum's remit covers a wide range of topics in the contemporary life sciences, including biotechnological developments such as genetically modified crops, and stem cell research. A key aspect of the Forum's program has been to convene cross-sector stakeholder workshops on specific topics, providing a 'safe space' for initiating dialogue across professional, cultural and ideological boundaries, with a view to long-term relationship building.[18]

US-UK JOINT WORKSHOP ON IMPROVING INTELLIGENCE ANALYSIS FOR EMERGING BIOTECHNOLOGY THREATS

In the context of this mission and work, the Genomics Policy and Research Forum therefore supported a September 2012 meeting in London to explore possibilities for enhanced analytic outreach in relation to emerging biotechnology threats, led by co-author [removed for anonymity] in [his/her] capacity as Genomics Forum "Bright Ideas" Visiting Fellow.[19] This

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meeting consisted of a mix of current and former intelligence practitioners and policy officials and social science and scientific experts from both countries.[20] The workshop was designed to:

> (1) examine new analytic approaches that take into account both social and technical factors in assessing emerging bioweapons and biotechnology threats;
>
> (2) create a new forward-looking dialogue and intellectual exchange between intelligence practitioners and academic experts on how both communities can think more holistically about bioweapons threats; and
>
> (3) challenge the conventional wisdom that substantive discussions of analytic methods for bioweapons threats can only occur in highly classified settings.

As will be described below, this unique pairing of experts and subjects revealed new insights into how to improve intelligence assessments on biotechnology and bioweapons threats. It also revealed continuing challenges in reforming assessments within existing intelligence work routines.

CRITICAL WORKSHOP FINDINGS

The workshop presentations and discussions identified two main issues worthy of intelligence attention: (1) the need for better conceptual models for understanding biotechnology development; and (2) the challenges of integrating these models (or any new analytic approaches) into existing intelligence culture and work practices. Underlying and linking these two issues, an important workshop finding was that it is essential to understand the context in which knowledge about biotechnology threats is produced and used. This context affects the ways in which intelligence practitioners collect, structure, classify, organize, and transfer data on potential threats.

1. TWO BIOTECHNOLOGY MODELS

A key panel at the workshop, entitled 'Understanding the Emerging Life Science Landscape,' examined two different models for explaining innovations in biotechnology and the life sciences.[21] One well-known model, the biotech revolution model, was described at the workshop by Gerald Epstein, Homeland Security Department Deputy Assistant Secretary for Chemical, Biological, Radiological, and Nuclear Policy. The 'biotech revolution' model emphasizes codified knowledge in biology and the material aspects of biotechnology, and assumes that biotechnologies develop with a fixed linear or exponential technological trajectory. Proponents of this model view biotechnologies as becoming more available due to the widespread geographical diffusion of biotechnology information, materials, infrastructure, and expertise across a wide range of commercial and academic settings. Biotechnology is seen as becoming more powerful, available, familiar, and decentralized. This model assumes that technology is the primary driver and that states, terrorists, or other non-state actors will readily exploit modern biological materials and techniques to lower technical barriers, obviate existing controls, and create vulnerabilities for harm. Under this model, the bioweapons threat is expected to grow in the future.

An alternative model, which could be dubbed the 'biotech evolution' model, was presented by University of Sheffield Professor of Sociology Paul Martin. This model focuses on the complex social, economic, scientific, and technical factors that shape biotech innovation and its applications – factors that can powerfully modulate potential bioweapons threats.[22] This model, based on decades of in-depth qualitative academic social science research, some involving longitudinal (20-30 year) case studies covering a range of biotechnologies, reveals a slower, multifaceted, and non-linear model for biotechnology development than the biotech revolution model. This is because biotechnological development occurs within social, natural, economic, and political contexts, and as a result, biotechnologies can develop in a number of different ways. This analytic approach studies local technical practices, as well as the larger laboratory, institutional, industrial, and environmental settings in which technologies are developed and used. These studies reveal that in the small number of cases where specific biotechnology products and innovations have emerged and been successful, this was the result of many decades of incremental collaborative research. Typically, it has taken 35 years for new biotechnology innovations to mature and be useful. While these case studies focused on commercial biotechnology rather than biological weapons development, they reveal patterns that may be common to all life science developments. Thus, these scholarly case studies demonstrate

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a different picture and understanding of biotechnology, its patterns of innovation, diffusion, translation, and uptake, that are worthy of serious consideration for intelligence.[23]

At the London workshop, Sonia Ben Ouagrham-Gormley, Assistant Professor in the Biodefense program at George Mason University, also drew on aspects of the biotech evolution model. She discussed how in her unclassified study of state and terrorist bioweapons programs, she found several very important 'intangible' factors in determining whether a group or state will successfully conduct scientific work and produce a weapon.[24] These factors go beyond purely technical issues, and involve the work organization, program management, structural organization, and the broader social environment that constitutes a weapons program.

For example, Gormley states that tacit knowledge (otherwise referred to as "know-how"), not just explicit knowledge, is important for bioweapons work – this kind of knowledge cannot be captured in codified forms, but involves the development of hands-on scientific know-how. Also, Gormley relates that technical developments, particularly in large scale technical projects, are the result of the cumulative and cooperative endeavors of teams of scientists, rather than just one scientist. Therefore, it is unlikely that one scientist could support a state/terrorist bioweapons program because their individual knowledge is not sufficient. Finally, scientific knowledge does not transfer easily—successful transfer typically requires some work to adjust the knowledge to the new location. Therefore, Gormley's overall take away message is that if we really want to understand whether and how successful/rapidly a state or non-state actor can produce a bioweapons program, we need to understand how these actors manage knowledge.

Gormley illustrated the importance of these factors by discussing differences between the U.S. and Soviet bioweapons programs. For example, the US bioweapons program had "multiple knowledge transmission belts"; that is, the management devised multiple mechanisms to share tacit knowledge among its team members. In contrast, the Soviet bioweapons program was much more fragmented due to its concerns over secrecy. Much of Soviet bioweapons work was compartmentalized, with multiple barriers to knowledge transfer. Although the Soviet bioweapons program was larger and lasted 60 years, which is much longer compared to the U.S. bioweapons program which existed for 25 years, the Soviets had problems in their weapons development due to this fragmentation of knowledge that ultimately prevented them from using the knowledge that they had within their own organization.[25] The U.S. bioweapons program was more successful in terms of managing knowledge than the Soviet program because the U.S. program was built as an integrated program with mechanisms for transferring knowledge between individuals and locations. For example, when a team member developed a product, this member went to the next research and development stage and would help those team members with any problems that they encountered. There were a few examples of Soviet management officials and institutes that mitigated the impact of Soviet rigidity for knowledge transfer, and these institutes were more successful and innovative in their weapons work compared to the more autocratic managerial styles that were the norm.

Gormley has also look at the role of intangible factors in smaller bioweapons programs, such as that of the Japanese religious group Aum Shinrikyo, as well as South Africa. Gormley

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finds that the South African program was mostly an assassination program (not a large scale weapons program), although it did have the expertise, budget, independence, and time necessary to develop potent weapons. However, little innovation resulted within this program. Gormley attributes this to the Soviet style management model that structured the South African program that limited the development and transfer of scientific knowledge. Chandre Gould, a scholar at the meeting who has spent over a decade investigating the South African state chemical and biological weapons program, also noted that the South African bioweapons program was largely a pedestrian effort. She believes (related to Gormley's presentation) that the secret nature of the South African program, where fear and suspicion prevailed, mitigated against creativity and productivity of the program. Through her research, Gormley found that the most vulnerable phase of a weapons program is the stage of knowledge accumulation, which involves important management dimensions that structure the technical work. She argued that intelligence and policy practitioners should focus on these intangible factors, and design and implement policies and programs that prevent or frustrate the use and transfer of weapons knowledge in the knowledge accumulation phase of a weapons program.

In spite of the purported ease of using biotechnology for harm, an intelligence practitioner (here referred to anonymously as IP1) commented at the workshop that even the most gifted bio-hackers face problems in producing a working weapon.[26] IP1 noted that one of the great downsides of 'off-the-shelf' technology is that if the technology doesn't work in the lab or garage as expected, it can be very difficult to determine and fix the problem, precisely for the

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reason that the technologies are 'off-the-shelf' and 'black-boxed' – the users may not possess the know-how to fix the underlying technical problem. Moreover, IP1 noted that there is also the inescapable reality of biological complexity. Viruses or bacteria, because they are living organisms with particular growth and environmental sensitivities, are not guaranteed to do what the weapons developer expects; even sophisticated state bioweapons programs have encountered these problems. IP1 also emphasized the challenges of effective delivery and dissemination of the biological agents that are also required for a mass casualty bioweapons attack. This requirement necessitates other kinds of weapons expertise, such as materials science and engineering knowledge to construct a workable weapon.

Those at the workshop who have conducted in-depth study of the social, organizational, economic, and historical dimensions of biotechnological development argued that the biotech revolution model is the wrong conceptual paradigm for understanding change and innovation in biotechnology and bioweapons threats. They called for a different conceptual model, such as the one described by Paul Martin, for understanding biotechnology development: one that is rooted in ideas of slow incremental innovation that integrates complex social, economic, environmental, and technical factors, and that takes a critical stance toward the high expectations that often characterize the rhetoric in the life science and biotechnology fields.[27] This alternative evolutionary framework is based on in-depth, longitudinal, and multi-disciplinary perspectives that focus on the *socio*-technical dimensions of how technological development, diffusion, and adoption occurs involving important micro-(laboratory) and macro-(industries, nations, regions, and global) level considerations. This analytic approach involves studying the detailed technical practices and related knowledge-generating activities that constitute the laboratory work for these technologies, as well as the larger organizational, national, and transnational contexts and time periods in which this work is situated.

Further, these talks and discussions at the workshop usefully highlighted the need to move away from thinking of biotechnology as a specific object or individual artifact, but instead as a socio-technical network comprised of both material and social things. Some useful questions that emerged from this discussion:

- How does one develop, stabilize, and sustain a socio-technical network to achieve a particular biotechnology product/application?
- What other circumstances and conditions are required (e.g., knowledge, training, teams, management, infrastructure)?
- How do we understand the different social actors in the networks and their complex connections?
- How can we better learn about scientific networks through micro-level studies of foreign scientific literature and scientific communities?
- What is involved in embedding knowledge in different kinds of networks (e.g., terrorist versus state)?

The outcome of these presentations and subsequent discussions was to highlight the need for a better, more refined conceptual model for explaining modes of, and changes in, technology development and transfer in biotechnology and the life sciences, and how these map onto specific threats, taking into account important social, economic, and organizational factors in addition to technical issues. In addition, discussions also emphasized that analysts need to pay attention to underlying assumptions about biotechnology and make room for diversity of hypotheses at any given time. Moreover, there is value in analysts interrogating what is absent from existing technological models and paradigms. For example, what kinds of social engineering (e.g., pedagogy, exchanges, teams, organization and management structures) is necessary for the development, diffusion, and use of specific biotechnologies for harm? What particular local conditions, practices contribute to the failure to develop these technologies?[28] What about crude or low tech bioweapons threats? How do the social requirements change when considering these lower tech threats? Both quantitative and qualitative research methods can help illuminate important social and technical factors that can shape bioweapons threats from emerging technologies. Another valid point raised about analysis at the workshop was the issue of considering not only the diversity of research methods needed, but also a diversity of experts (to include social scientists) who can provide alternative or contrarian approaches to thinking about biotechnology and bioweapons threats.

Finally, as well as the socio-technical and organizational factors that either enable or inhibit bioweapons development, there may well be socio-cultural motivations and taboos in relation to both development and deployment of biological weapons. These factors similarly require social scientific investigation and are not captured by the "biotech revolution" model. As one intelligence practitioner (here referred to as IP2) at the workshop pointed out, bioweapons seem to receive relatively little investment from terrorist groups. IP2 mentioned that according to journalist accounts, al Qaeda is believed to have spent approximately $2,000 on their bioweapons program, versus nearly $500,000 for their 11 September attacks.[29] Bioweapons thus seem to be the least funded, least resourced type of weapon for al Qaeda. As IC2 asked, if we assume that capabilities are ubiquitous and that actors do have intent, why have we not seen more bioweapons attacks?

One possible answer that emerged in discussion is that there may be some kind of socio-cultural taboo against the deployment of these kinds of weapons. For example, some terrorists may be deterred from deploying these weapons if they would lose support from their constituency in using them (though the same may or may not be applicable to lone or 'rogue' scientists). On the same question of motivations, but in relation to those working in state-sponsored bioweapons development programs, Chandre Gould pointed out that very few people intentionally use their knowledge and skills for 'evil,' as they see it. In her research case study of the South African chemical and biological weapons program, those involved justified their actions in terms of patriotism, careerism, and self-preservation. Thus, understanding socially and culturally conditioned motivations and norms on both sides of state and non-state conflicts would

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seem to be an essential step towards improving intelligence and security, both short- and long-term.

Furthermore, terrorists may not be interested in biological weapons due to the finicky nature of working with most biological organisms and the socio-organizational complexity that is needed to develop effective biological weapons. Terrorists may simply find other low tech, conventional methods more accessible and reliable for their purposes. At the workshop Sonia Ben Ouagrham-Gormley found that the bioterrorism program carried out by the Japanese religious group Aum Shinrikyo failed to produce any successes in its bioweapons development activities due to a combination of social and technical problems in the group.[30] Regardless of what explains the historical lack of terrorists' use of biological agents, there remains validity in needing better analysis in order to stay ahead of how biotechnology might change to be more of an enabling technology for terrorism, and as terrorists interests and skills in technology may change in the future.

2. INTELLIGENCE CULTURE AND WORK PRACTICES

A second critical issue that emerged in the workshop discussions centered on the challenges of integrating new analytic approaches into existing intelligence culture, work practices, and priorities. Bioweapons threats attract relatively little resourcing within intelligence. IP2 described how intelligence analysts face resource constraints when assessing bioweapons threats: issues involving bioweapons have never been the '800-pound gorilla in the room' (in contrast to nuclear threats). Biological weapons typically receive a lower emphasis from intelligence managers and policymakers; the topic is often the 'last on the list,' and frequently doesn't make it into the conversation. Therefore, there are practical resource constraints that can shape what analysts are able to receive in terms of intelligence collection, which subsequently can shape analysis.

In addition, it is important to examine how existing intelligence culture can shape analysis—even when new methods are introduced. This is not a new problem, but a persistent one in intelligence that challenges efforts for analytic improvement. Several intelligence practitioners at the meeting stated that intelligence analysts face pressures continually to produce 'current intelligence reports' – what one intelligence practitioner at the meeting called 'intelligence journalism.' With this type of work, intelligence analysts are consumed daily with having to keep up with producing current intelligence reports for a variety of policy customers---this comes at the expense of developing a long-term, in-depth analytic program.[31] Moreover, other practitioners noted that since the 2003 Iraq intelligence failures, the U.S. intelligence community has become highly risk averse in making analytical judgments. At the same time, there is a climate of fear and anxiety amongst both policymakers and the public, who see a world of potential threats, particularly in light of the revolution of the life sciences which seems to have opened up a Pandora's Box of bioweapons possibilities for concern.

According to some of these practitioners at the workshop, the time pressures and risk aversion in intelligence have led to the development of an 'audit culture,' where intelligence

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analysts rely upon checklists and structured analytic techniques in order to increase confidence in their judgments. Although these tools and techniques can be useful to map out reasoning of an analyst's judgment to a manager or customer, some analysts rely on these to produce a 'correct answer' instead of seeing the value more as thinking tools or ways to get analysts from different agencies in a room together to talk collectively about a problem. The practitioners also noted that analysts also need to be able to interrogate conventional wisdom, and spend time to investigate whether it is accurate, instead of just relying and focusing their attention on a simple checklist process. According to practitioners at the workshop, a reliance on tools and checklists has made producing intelligence a more bureaucratic process that comes at the expense of building up in-depth subject-matter expertise, mentoring relationships between junior and senior analysts, and long-term institutional knowledge.

Furthermore, intelligence practitioners stated that analysts face challenges in acquiring and processing information relating to bioweapons threats. According to these practitioners, there is typically little evidence of either state or non-state actors developing biological weapons. By contrast, there is an overload of information about general biotechnology developments, which begs for better tools or conceptual aids to help the analyst sort through it. This led to further discussions at the workshop about the importance of training for intelligence analysts. Yet practitioners noted that training is supported in some agencies more than others, and the quality of training can vary. Moreover, although training and sabbatical opportunities exist, these involve taking analysts 'offline' from their analytical responsibilities, which leads to time and work pressures for the analyst and his or her office. These training opportunities may also be cut back in an increasingly constrained resource environment. Practitioners noted that other problems can emerge when analysts go away training, but then face resistance from their home office when they try to apply these new skills on the job.

Related to the challenge of acquiring and processing information in the context of limited resources is the need to process scientific materials in languages other than English. Another participant noted that the assessment of biological threats tends to be based on literature reviews that are heavily biased towards research published in English, excluding literature in other languages. To obtain and review the comprehensive scientific data about a pathogen, this participant emphasized that access to libraries, support from skilled librarians and linguists, creative search strategies, advanced database handling, and the establishment and support of a global scientific contact network are essential. Securing resources for these crucial services is a question again of prioritization.

Practitioners also noted the importance of having the right specialists and subject matter experts on hand to be able to analyze bioweapons- and biotechnology-related information, and not rely on analysts who are primarily 'generalists' (those who have worked on a variety of different accounts for short periods of time). Given the complexity of the assessments, some practitioners at the meeting argued for the need to create and provide managerial support for a range of analytic skills and analytic teams to work on the complex array of issues—organizational, financial, technical, and political—that can shape a weapons program, instead of

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leaving individual analysts to handle this multifaceted problem all on their own. Another signaled that because there exist longstanding problems in retaining analysts, there is little 'expertise' or long-term institutional knowledge about bioweapons issues in the U.S. intelligence community. This can exacerbate problems of inexperienced analysts who rely on outdated information, faulty assumptions, or poor frameworks when making analytical judgments.

Another practitioner (whom we call IP3) commented that pieces of analytic tradecraft in intelligence can be incredibly valuable, but that these pieces are not necessarily being shared, captured, or documented across organizations. Therefore, this raises the question: how can one improve this practically or organizationally? IP3 further commented on his experience in working in a tradecraft cell, where he saw the importance of the job as primarily being a 'therapist for analysts,' rather than just thinking of tradecraft as a technique or tool. IP3 explained that with the growth in collaboration among intelligence analysts, this has meant that joint projects come under fire due to entrenched agency views, resulting in the analysis and assessment being a dynamic, never-ending process, with organizations having vested interests in what they have written before. In this kind of environment, two analytic teams may take opposing sides and therefore they need a 'therapist' (tradecraft specialist) to act as a mediator to help the teams expose biases, understand each other's perspective, work together, and resolve the conflict to find a path forward. However, IP3 noted that the use of tradecraft in this way takes a lot of time, which is not always available in intelligence work.

Other practitioners commented on the importance of trust relationships in the production of knowledge for intelligence assessments. This trust consists of formal and informal relationships for acquiring expertise and data, externally or internally. For example, for certain kinds of in-depth analysis of scientific literature, the intelligence analyst needs to develop trust relationships with scientists, librarians, and others to help find and gather important information. Other practitioners stated that there are also trust issues among intelligence analysts related to sharing information and databases, and the need to make the knowledge production process (and development of judgments) more transparent. One academic expert at the meeting noted that the issues facing social science are similar to those facing intelligence in terms of the production of knowledge. Both types of knowledge producer must consider how to trust sources of knowledge, capture institutional memory, and effectively conduct peer review processes. The academic scholar explained that the social sciences have standardized methodologies, communities of practice, and peer review processes to aid in verifying claims and knowledge.

Several interesting discussions at the workshop noted the divisions between intelligence collection and analysis, which were described by intelligence practitioners as 'two different disciplines.' The academic social scientists at the workshop found this divide puzzling and intriguing. For historical and security reasons there is a rationality and logic within intelligence for why this separation between collection and analysis exists. However, one academic participant noted that this separation then should focus analytic attention on 'how do you do

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knowledge production across the junctions and ensure respect between the different areas of work?'

These statements by intelligence practitioners about the daily work challenges facing analysts highlight the persistent problems in intelligence work culture, and underscore that it is useful to consider how, and to what extent, new analytic approaches can be successfully adopted and used within existing work flows and practices, and the effort and managerial support that would be required for that to happen in this context. These issues discussed at the workshop illuminated for the academic participants how much the academic community does not know or grasp about the production of knowledge in intelligence, and the utility of making that a focused area of research in order to help better translate academic analytic methods to an intelligence context. Others at the workshop noted that academic social scientists could be brought into the intelligence community to document and provide insights on how knowledge is produced in intelligence.[32] From their more distanced perspective, academic scholars can identify blind spots and disconnects in analyses. Social scientists can also be useful in laying out the ways of seeing and framing a problem, and to be aware of the consequences of path dependencies once a particular framing is chosen. Therefore the academic social scientist can play a useful outsider role by highlighting the analytic path that intelligence analysts are on, and drawing attention to alternative paths, in order to enable practitioners to see gaps and suggest new ways of intervening and reshaping their assessments.

CONCLUSIONS

This U.S.-UK workshop highlighted the value of bringing new analytic insights from the academic social science disciplines to the problem of intelligence analysis on emerging bioweapons threats. These kinds of engagements, however, can also be beneficial to academic scholars because they allow them to understand better the practical, working-level and institutional challenges that face intelligence analysts in bringing new ideas, techniques, and tools to their work. Thus there is much benefit in bringing the academic and intelligence communities in close conversation with one another to further both communities' understanding of how to improve assessments of bioweapons threats. More initiatives along these lines should be supported by government and non-government funds. In the UK, 'Global Uncertainties' is one of six Research Councils UK (RCUK) priority themes, 'examining the causes of insecurity and how security risks and threats can be predicted, prevented and managed.' Both terrorism and biological weapons are core areas within this theme.[33] The Economic and Social Research Council is leading the program on behalf of RCUK, while the various UK research councils fund research in these areas and could support new links across the academic-security divide.

On the US side, the National Intelligence Council's (NIC) Associates Program has been designed to bring multidisciplinary expertise from academia, think tanks, and the corporate world to the U.S. intelligence community. Although the NIC has largely drawn on conventional technical experts to inform the intelligence community on bioweapons threats, it could be expanded, with managerial support and some new resources, to bring in a larger collection of social science experts to work on emerging biotechnology issues.[34] Moreover, the Department of State's Global Futures Forum could also be a natural counterpart to initiate these increased engagements, as it has a track record of engaging with a diverse set of experts in the academic community in an unclassified manner. The Office of the Director of National Intelligence's Biological Sciences Experts Group (BSEG) aims to increase academic expertise into intelligence, but some of the existing limitations of this Group include a primary focus on technical expertise, a requirement that academics obtain security clearances, and the location of BSEG meetings within classified spaces.[35] BSEG, however, could be modified to become a more open and inclusive body for academic-intelligence discussions and engagements. Additionally, other research and engagement initiatives could be launched through the National Science Foundation, in an analogous fashion to Research Councils UK.

As this workshop has illustrated, new and different ways of analyzing bioweapons-related technologies and threats will help policymakers, intelligence analysts, and academic scholars to produce better-informed judgments, advice, and decisions about national security by providing an understanding of the more complex and diverse character of bioweapons threats as these evolve in the years to come.

[1] Office of the Director of National Intelligence, 'Intelligence Community Directive 205: Analytic Outreach,' (16 July 2008), pp. 1-6, accessed 11 April 2013, http://www.ncix.gov/publications/policy/docs/ICD_205-Analytic_Outreach.pdf.
[2] Ibid, p.1.
[3] Ibid.

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[4] Ibid, pp. 1, 4.

[5] Anonymous intelligence analyst, email communication with [author name removed for anonymity], 21 October 2012.

[6] Ibid.

[7] Testimony to the Senate Armed Services Committee, 27 March 1996, (statement of Gordon C. Oehler, 'The Continuing Threat from Weapons of Mass Destruction'), accessed 11 April 2013, https://www.cia.gov/news-information/speeches-testimony/1996/go_toc_032796.html.

[8] National Security Council, *National Strategy for Countering Biological Threats* (November 2009), p. 2, accessed 11 April 2013, http://www.whitehouse.gov/sites/default/files/National_Strategy_for_Countering_BioThreats.pdf.

[9] U.S. Central Intelligence Agency, 'The Darker Bioweapons Future,' (3 November 2003), accessed 11 April 2103, http://www.fas.org/irp/cia/product/bw1103.pdf ; James B. Petro, Theodore R. Plasse, and Jack A. McNulty, 'Biotechnology: Impact on Biological Warfare and Biodefense,' *Biosecurity and Bioterrorism: Biodefense Strategy, Practice, and Science* 1/ 3 (September 2003), pp. 161-168; James B. Petro and David A. Relman, 'Understanding Threats to Scientific Openness,' *Science* 302/5652 (12 December 2003), p. 1898; Institute of Medicine and National Research Council, *Globalization, Biosecurity, and the Life Sciences* (Washington, DC: National Academies Press, 2006).

[10] James B. Petro, 'Intelligence Support to the Life Science Community: Mitigating Threats from Bioterrorism,' *Studies in Intelligence* 48/3 (2004), pp.57-68.

[11] For example, a number of policy reports and actions have calls for increased scientific engagement. See: Institute of Medicine and National Research Council. *Globalization, Biosecurity, and the Life Sciences* (Washington, DC: National Academies Press, 2006); Commission on the Intelligence Capabilities of the United States Regarding Weapons of Mass Destruction, *Report to the President of the United States* (31 March 2005), available at: www.ise.gov/sites/default/files/wmdreport0.pdf; Kenneth Brill, "Statement for the Record: Hearing on Bioscience and the Intelligence Community (Part II): Closing the Gap." Subcommittee on Prevention of Nuclear and Biological Attack of the U.S. House of Representatives Committee on Homeland Security, (4 May 2006), available at: www.gpo.gov/fdsys/pkg/CHRG-109hhrg35695/html/CHRG-109hhrg35695.htm; Biological Sciences Experts Group, "Charter, " available at: www.fas.org/irp/eprint/bseg-concept.pdf; U.S. Central Intelligence Agency, "The Darker Bioweapons Future," (3 November 2003), available at: www.fas.org/irp/cia/product/bw1103.pdf.

[12] Ibid.

[13] Claire Donovan, 'The Australian Research Quality Framework: A live experiment in capturing the social, economic, environmental, and cultural returns of publicly funded research,' *New Directions for Evaluation* 118 (2008), pp. 47–60; European Commission, *Improving Knowledge Transfer between Research Institutions and Industry across Europe: Embracing Open Innovation* (COM 2007/182) (Brussels: European Commission, 2007); Economic and Social Research Council, *Strategic Plan 2009-2014* (Swindon: ESRC, 2009); Ben Jongbloed and Arend Zomer, 'Valorisation, Knowledge Transfer and IP: Creating Value from Academic Knowledge,' in P. Temple (ed.) *Universities in the Knowledge Economy: Higher Education Organisation and Global Change* (London: Routledge, 2010); Jordi Molas-Gallart and Elena Casto-Martinez, 'Ambiguity and conflict in the development of 'Third Mission' indicators,' *Research Evaluation* 16/4 (2007), pp. 321-330.

[14] Economic and Social Research Council, *ESRC Research funding guide* (Swindon: ESRC, 2012); *Assessment framework and guidance on submissions*, Research Excellence Framework (2011), accessed 11 April 2013, http://www.ref.ac.uk/media/ref/content/pub/assessmentframeworkandguidanceonsubmissions/02_11.pdf; Corie Lok, 'Science for the Masses,' *Nature* 465 (27 May 2010), pp. 416-418; James Britt Holbrook (ed.), 'Special Issue: US National Science Foundation's Broader Impacts Criterion,' *Social Epistemology* 23/3-4 (2009), pp. 177-345.

[15] See: National Research Council, *Intelligence Analysis for Tomorrow: Advances from the Behavioral and Social Sciences* (Washington, DC: National Academies Press, 2011). Also, the Cultural Knowledge Consortium (CKC) was created in 2012 to 'facilitate access among multi-disciplinary, worldwide, social science knowledge holders that

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fosters collaborative engagement in support of socio-cultural analysis requirements. The CKC supports US government and military decision-makers, while supporting collaboration and knowledge sharing throughout the socio-cultural community.’ See: https://www.culturalknowledge.org/.

[16] For example, see: Sandra M. Nutley, Isabel Walter and Huw T.O. Davies, *Using Evidence: How Research Can Inform Public Services* (Bristol: Policy Press, 2007).

[17] See Christine Knight and Claire Lightowler, ‘Reflections of ‘knowledge exchange professionals’ in the social sciences: emerging opportunities and challenges for university-based knowledge brokers,’ *Evidence & Policy* 6/4 (2010), pp.543-556.

[18] For further details and reflection on the Forum’s work, see Emma K. Frow, ‘A forum for ‘doing society and genomics’,’ *EMBO Reports* 10/4 (2009), pp. 318-321.

[19] A brief description of this meeting can be found at: http://www.genomicsnetwork.ac.uk/forum/events/pastevents/workshops/title,26429,en.html. Funding support for the workshop was provided by the UK ESRC Genomics Policy and Research Forum. The Genomics Forum is based at the University of Edinburgh and is part of the ESRC Genomics Network (EGN), a major ESRC investment spanning five of the UK's leading universities examining the development and use of the science and technologies of genomics.

[20] The workshop included the following panels: (1) Description of the intelligence problem; (2) Government Perspectives for Analysis; (3) Understanding the Emerging Life Science Landscape; (4) Revisiting the Past and Present to Understand the Future in the Life Sciences; (5) Novel Science and Social Science Approaches to Assess Biotechnology and Bioweapons Threats; (6) New Perspectives to Understand “Dark Creativity” Illicit Activity, and the Abuse of the Life Sciences. Speakers included: Glenn Cross, US Federal Bureau of Investigation; Anthony Treubrodt, US Federal Bureau of Investigation; Carl Ford, Georgetown University, USA; Lawrence Freedman, King’s College, UK; Filippa Lentzos, King’s College, UK; Gerald Epstein, US Department of Homeland Security; Paul Martin, University of Sheffield, UK; Brian Rappert, University of Exeter, UK; Stephen Hilgartner, Cornell University, USA; Sonia Ben Ouagrham-Gormley, George Mason University, USA; Keelie Murdock, Rathenau Instituut, Netherlands; Brian Balmer,University College London, UK; Michael Goodman, King’s College, UK; Kimberly Glasgow, John Hopkins University Applied Physics Laboratory, USA; Ken Olson, George Mason University, USA; Emma Frow, Science Technology & Innovation Studies, University of Edinburgh, UK; Chandre Gould, Institute for Security Studies, South Africa; Ronald Schouten, Harvard University, USA; Caitriona McLeish, University of Sussex, UK; Kathleen M. Vogel, Cornell University, USA; in addition, there were speakers who chose to remain anonymous from the UK Ministry of Defence, the US Army Medical Research Institute for Infectious Diseases, and the U.S. Department of State.

[21] For a more detailed discussion of the models presented at the workshop see [author name removed for anonymity]; Also, see: [author name removed for anonymity].

[22] For a few examples, see: Paul Nightingale, ‘Technological capabilities, invisible infrastructure, and the un-social construction of predictability: The overlooked fixed costs of useful research,’ *Research Policy* 33/ 9 (November 2004), pp. 1259-1284; Paul Nightingale and Paul Martin, ‘The myth of the biotech revolution,’ *Trends in Biotechnology* 22/11 (November 2004), pp. 564-569.

[23] For some additional references that discuss the socio-organizational complexities of biotech development, see: Michael M. Hopkins, et al. “The myth of the biotech revolution: an assessment of technological, clinical, and organizational change. *Research Policy*, vol. 36, no. 4 (May 2007):566–589; Gary Pisano, *Science Business: the Promise, the Reality, and the Future of Biotech*. (Boston: Harvard Business School, 2006); Roberta Joppi, Vittorio Bertele, and Silvio Garattini, “Disappointing biotech,” *British Medical Journal*, vol. 331, iss. 7521 (October 2005): 895–897; Adam Hedgcoe and Paul Martin, “The Drugs Don’t Work: Expectations and the Shaping of Pharmacogenetics,” *Social Studies of Science*, vol. 33, no. 3, (June 2003): 327–364; David F. Horrobin, “Modern biomedical research: an internally self-consistent universe with little contact with medical reality?” *Nature Reviews*

Drug Discovery, vol. 2, (February 2003): 151–154; David F. Horrobin, "Realism in drug discovery: could Cassandra be right?" *Nature Biotechnology*, vol. 19, no. 12, (December 2001): 1099–1100.

[24] For a more detailed discussion of this argument, see: Sonia Ben Ouagrham-Gormley, 'Barriers to bioweapons: Intangible obstacles to proliferation,' *International Security* 36/4 (Spring 2012), pp. 80-114.

[25] Other references for the Soviet bioweapons program that discuss its complexity are: Milton Leitenberg and Raymond A. Zilinskas, *The Soviet Biological Weapons Program: A History* (Cambridge: Harvard University Press, 2012); Kathleen M. Vogel, "Bioweapons Proliferation: Where Science Studies and Public Policy Collide," *Social Studies of Science*, vol. 36, no. 5 (October 2006): 659-690.

[26] Discussions within the workshop were based on Chatham House rules. Therefore no attribution is given to those who provided comments during the question and answer period, in order to protect anonymity and facilitate a free flow of discussion.

[27] Other historians of technology have called for more evolutionary frameworks for understanding both old and new technologies. For some examples, see: David Edgerton, *The Shock of the Old: Technology and Global History Since 1900* (Oxford: Oxford University Press, 2011); James W. Cortada, *The Digital Flood: The Diffusion of Information Technology Across the U.S., Europe, and Asia* (Oxford: Oxford University Press, 2012).

[28] Often times, much is gained analytically by studying failure in-depth, although this is often overlooked. For one powerful example of the utility of studying technological failure, see: Diane Vaughan, *The Challenger Launch Decision: Risky Technology, Culture, and Deviance at NASA* (Chicago: University of Chicago, 1997).

[29] For example, see: Alan Cullison, 'Inside al-Qaida's Hard Drive,' *Atlantic Monthly* 294/2 (2004); Alan Cullison and Andrew Higgins, 'Forgotten Computer Reveals Thinking Behind Four Years of Al-Qaida Doings,' *Wall Street Journal* (31 December 2001); Andrew Higgins and Alan Cullison, 'Terrorists Odyssey: Saga of Dr. Zawahri Illuminates Roots of Al-Qaida Terror,' *Wall Street Journal* (2 July 2002).

[30] Other published work that has discussed the difficulties in weaponizing and using biological agents include: Milton Leitenberg, *Assessing the Biological Weapons and Bioterrorism Threat* (Carlisle: U.S. Army War College, Strategic Studies Institute, 2005); Jonathan B. Tucker, *Toxic Terror: Assessing Terrorist Use of Chemical and Biological Weapons* (Cambridge: MIT Press, 2000).

[31] For more discussion of these current intelligence pressures in bioweapons assessments, see: [author name removed for anonymity]. The general problems of current intelligence reporting have also been noted by other intelligence practitioners (current and former) and intelligence scholars. For some examples, see: Rob Johnston, *Analytic Culture in the U.S. Intelligence Community: An Ethnographic Study* (Washington, DC: Center for the Study of Intelligence, 2005); Roger Z George, Analyzing Intelligence: Origins, Obstacles, and Innovations (Washington, DC: Georgetown University Press, 2008); Dennis M. Gormley, *Transforming Intelligence through New Institutional Arrangements* (Ridgway Center Working Papers. Pittsburgh, PA: Matthew B. Ridgway Center for International Security Studies, 2007); Amy B. Zegart, 'CNN with Secrets': 9/11, the CIA, and the Organizational Roots of Failure,' *International Journal of Intelligence and Counterintelligence* 20/1 (Spring 2007) pp. 18– 49; Gregory F. Treverton, *The Next Steps in Reshaping Intelligence (*Santa Monica, CA: RAND, 2005); John A. Gentry, 'A Framework for Reform of the U.S. Intelligence Community,' (6 June 1995), accessed 11 April 2013 at: http://www.fas.org/irp/gentry/.

[32] One intelligence report that illustrates the utility of this approach is: Rob Johnston, Analytic Culture in the U.S. Intelligence Community: An Ethnographic Study (Washington, DC: U.S. Central Intelligence Agency, Center for the Study of Intelligence, 2005).

[33] See http://www.globaluncertainties.org.uk/about/

[34] For an example, see: National Intelligence Council, *Mapping the Global Future* (Pittsburgh, PA: Government Printing Office, 2004), accessed 11 April 2013, http://www.foia.-cia.gov/2020/2020.pdf.

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[35] Yudhijit Bhattacharjee, ‘Panel provides peer review of intelligence research,’ *Science* 318/5856 (7 December 2007), p. 1538; Biological Sciences Experts Group. ‘Charter,’ unclassified document, accessible at: http://www.fas.org/irp/eprint/bseg-concept.pdf.